

WHAT IS CLAIMED IS:

1. A filter element comprising
a plurality of resonators that are arranged in
5 series arms and parallel arms in a circuit,
at least one of the series-arm resonators
including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.

10

2. The filter element as claimed in claim 1,
wherein at least one of the parallel-arm resonators
includes a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
15 parallel.

3. A filter element comprising
a plurality of resonators that are arranged in
series arms and parallel arms in a circuit,
20 at least one of the parallel-arm resonators
including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.

25 4. A filter element comprising
a plurality of resonators that are arranged in
series arms and parallel arms in a circuit,
at least the series-arm and/or parallel-arm
resonators at the first stage on the signal input side
30 including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.

5. The filter element as claimed in claim 1,
35 wherein the series-arm resonator including the
plurality of single-terminal pair piezoelectric thin-
film resonators connected in parallel has an admittance

matched with the admittance of at least one of the other series-arm resonators.

5 6. The filter element as claimed in claim 2,
wherein the parallel-arm resonator including the plurality of single-terminal pair piezoelectric thin-film resonators connected in parallel has an admittance matched with the admittance of at least one of the other parallel-arm resonators.

10

 7. The filter element as claimed in claim 1, wherein the single-terminal pair piezoelectric thin-film resonators connected in parallel have exciting parts that are uniform in size.

15

 8. The filter element as claimed in claim 1, which has a ladder filter structure.

20 9. The filter element as claimed in claim 1, which has a lattice filter structure.

 10. The filter element as claimed in claim 1, wherein the single-terminal pair piezoelectric thin-film resonators each comprises:

25 a substrate that contains at least one of silicon, glass, and ceramics;

 a piezoelectric substrate that contains at least one of aluminum nitride, zinc oxide, lead zirconate titanate, and lead titanate; and

30 an upper electrode film and a lower electrode film that are single-layer or multi-layer films containing at least one of aluminum, copper, gold, molybdenum, tungsten, tantalum, chromium, titanium, platinum, and rhodium.

35

 11. The filter element as claimed in claim 1, wherein the parallel-arm resonators each includes an

upper electrode film having a SiO₂ film formed thereon.

12. A filter device comprising:
a filter element; and
5 a package that houses the filter element,
the filter element including
a plurality of resonators that are arranged in
series arms and parallel arms in a circuit,
at least one of the series-arm resonators
10 including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.
13. A duplexer comprising
15 a transmission filter element and a reception
filter element,
the transmission filter element including a
plurality of resonators that are arranged in series
arms and parallel arms in a circuit,
20 at least one of the series-arm resonators
including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.
- 25 14. A duplexer comprising
a transmission filter element and a reception
filter element,
the transmission filter element including a
plurality of resonators that are arranged in series
30 arms and parallel arms,
at least one of the parallel-arm resonators
including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.
- 35 15. A high-frequency circuit that transmits and
receives radio signals, comprising:

a first amplifier that amplifies transmission signals;

a second amplifier that amplifies reception signals; and

5 a duplexer that includes a transmission filter element and a reception filter element,

the transmission filter element including a plurality of resonators that are arranged in series arms and parallel arms in a circuit, and

10 at least one of the series-arm resonators including a plurality of single-terminal pair piezoelectric thin-film resonators connected in parallel.

15 16. A high-frequency circuit that transmits and receives radio signals, comprising:

a first amplifier that amplifies transmission signals;

20 a second amplifier that amplifies reception signals; and

a duplexer that includes a transmission filter element and a reception filter element,

25 the transmission filter element including a plurality of resonators that are arranged in series arms and parallel arms in a circuit, and

at least one of the parallel-arm resonators including a plurality of single-terminal pair piezoelectric thin-film resonators connected in parallel.

30

17. A high-frequency circuit that transmits radio signals, comprising:

an amplifier that amplifies transmission signals; and

35 a filter element that filters the transmission signals,

the filter element including a plurality of

resonators that are arranged in series arms and parallel arms in a circuit, and

at least one of the series-arm resonators including a plurality of single-terminal pair
5 piezoelectric thin-film resonators connected in parallel.

18. A high-frequency circuit that transmits radio signals, comprising:

10 an amplifier that amplifies transmission signals; and

a filter element that filters the transmission signals,

the filter element including a plurality of
15 resonator that are arranged in series arms and parallel arms in a circuit, and

at least one of the parallel-arm resonators including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
20 parallel.